

# Spatial and Temporal Patterns of Paralytic Shellfish Poisoning Toxin in Puget Sound Shellfish

**Timothy A. Determan**

*Office of Food Safety and Shellfish Programs, Washington State Department of Health*

## Abstract

The Washington State Department of Health (DOH) monitors levels of paralytic shellfish poisoning toxin (PSP) in mussels taken every two weeks from sentinel sites located throughout Washington State marine waters. Results from thirty sites in Puget Sound are examined annually to determine spatial patterns and temporal trends as part of the Puget Sound Ambient Monitoring Program (PSAMP). Results of the analysis through December 1999 will be presented.

## Background

Washington State has monitored biotoxins in shellfish since the 1930s. Monitoring was greatly expanded by the early 1960s. At present, shellfish samples are analyzed for biotoxins from hundreds of sites throughout Puget Sound and coastal waters. In 1990, the Washington State Department of Health (Health) set up a Sentinel Monitoring Program to provide systematic early warning of blooms of toxic algae that produce biotoxins, such as paralytic shellfish poisoning (PSP) toxin. Additionally, Health analyzes PSP data from the Sentinel stations for spatial patterns and temporal trends in Puget Sound.

## Public Health Objective

When the level of PSP in a particular shellfish species exceeds the FDA action level (80 ug per 100g shellfish tissue), Health closes commercial and recreational harvest areas for that species. Health issues warnings to commercial shellfish growers, local health agencies, tribal resource agencies, and the public. Warnings are issued via electronic and print media, the Department of Health Biototoxin Hotline (800.562.5632), and by Internet (<http://www.doh.wa.gov/ehp/sf/biototoxin.HTM>). The areas are reopened only when continued monitoring indicates safe conditions have returned.

## PSAMP Objective

Health reports results to the Puget Sound Water Quality Action Team as a participating agency of the Puget Sound Ambient Monitoring Program (PSAMP). This year's analysis includes 34 Sentinel sites.

## PSP Toxin

A number of genera of marine phytoplankton produce an array of chemically similar neurotoxins of different toxicities (Boczar and others 1988). These toxins act together to produce PSP. Symptoms may progress from numbness and tingling of lips, and loss of muscular coordination, to respiratory arrest and, ultimately, death. There is no known antidote. Death results in about 15% of cases worldwide (Nishitani and others 1994). PSP toxin accumulates in marine animals that feed either directly on toxic phytoplankton or secondarily on consumers of toxic phytoplankton. The causative agent in Puget Sound is the dinoflagellate *Alexandrium catenella*. Bivalve shellfish (oysters, mussels, clams, etc.) concentrate biotoxin when they filter toxic phytoplankton out of the water while feeding. People are poisoned when they eat shellfish or other marine life that contain excessive levels of PSP toxin.

## Sampling and Analytical Methods

The Department of Health Biototoxins Program samples many shellfish species and uses diverse sampling strategies to monitor biotoxins in marine animals. In 1990, Health inaugurated a "Sentinel Biototoxins Monitoring Program" based on a rigorous sampling design (Nishitani 1990) developed to minimize the effects of variation. The mussel sampled is generally the blue mussel, *Mytilus edulis*. However *M. galloprovincialis* (possibly a subspecies of *M. Edulis*) and *M. californianus* are sampled at a few Puget Sound sites. At most sites, wire mesh cages (40cm x 40cm x 20cm; 2.5cm mesh size) are periodically

stocked with mussels. The cages are then suspended about one meter deep below floats and docks, and sampled every two weeks year-round. At a few sites, natural-set mussels are scraped from floats, pilings and rocks. Seventy to 100 average-sized mussels (1 to 2 inches in length) provide 100 grams of tissue for analysis. The mussels are put into one-gallon "Ziploc" bags, chilled, and shipped to the Health Laboratory in Seattle. The samples are analyzed using the mouse bioassay (APHA 1984).

## Results

### Spatial Distribution of PSP in Year 2000

Results for PSP in shellfish at each Sentinel site in Year 2000 were sorted into four categories based on PSP impact. These **PSP Impact Categories** are as follows:

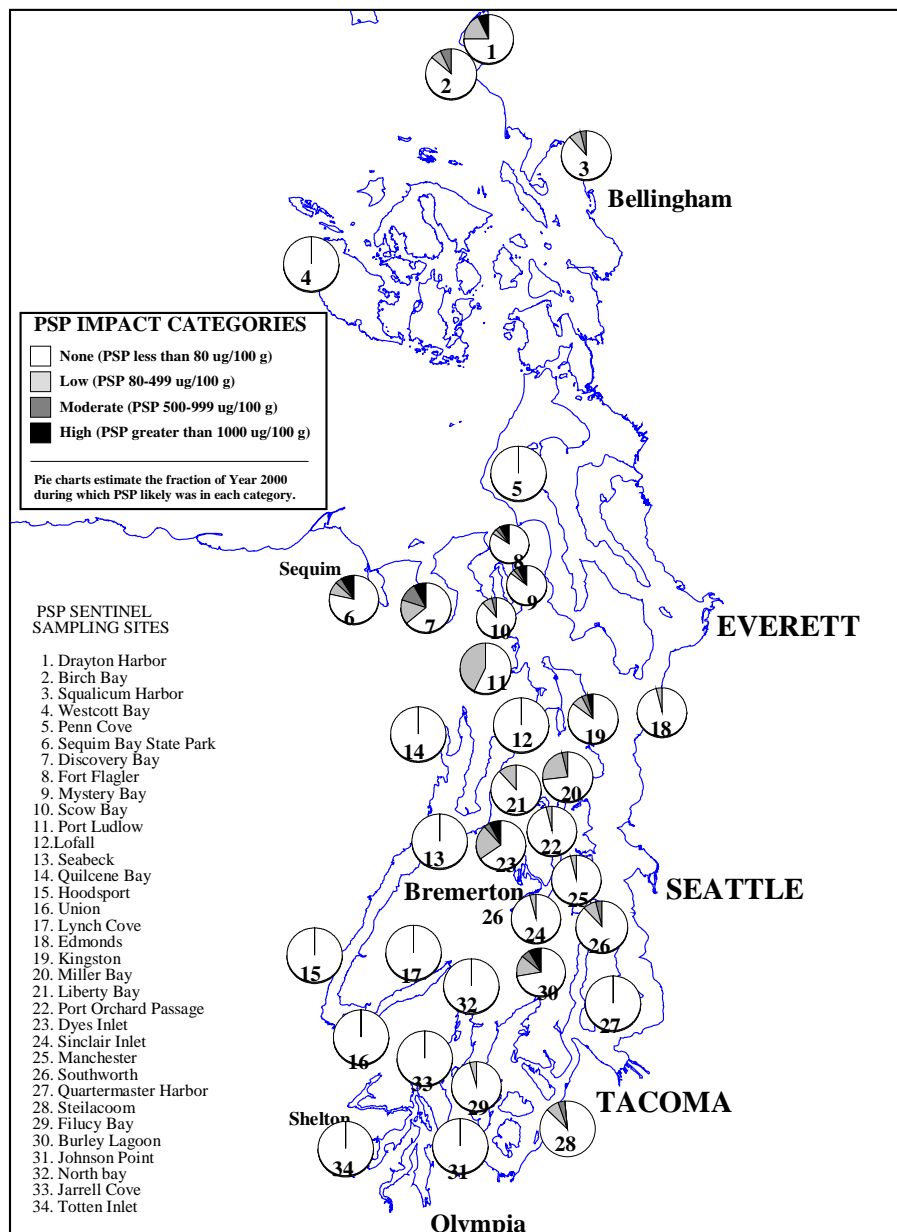
**None:** PSP level was less than 80 ug per 100 grams shellfish tissue (FDA action level);

**Low:** PSP level ranged from 80-499 ug per 100 grams shellfish tissue;

**Moderate:** PSP level ranged from 500-999 ug per 100 grams shellfish tissue;

**High:** PSP level was greater than 1000 ug per 100 grams of shellfish tissue.

Each pie chart in Figure 1 shows the fraction of PSP results during Year 2000 in each PSP Impact Category. Thirteen sites had no PSP impact (Westcott Bay in San Juan Island, Penn Cove in Saratoga Passage, 6 sites in Hood Canal, Quartermaster Harbor on Vashon Harbor, and 4 sites in south Puget Sound west of Nisqually Reach.



**Figure 1.** Spatial distribution of PSP in Year 2000

### Ranking of PSP Sites According to PSP Impact

Twenty-one of 34 Sentinel sites had some measure of PSP impact during Year 2000 (Figure 1). These sites were ranked according to PSP impact by calculating an “**Impact Factor**” for each site by multiplying the percentage falling into each impact-category by its respective weighing factor:

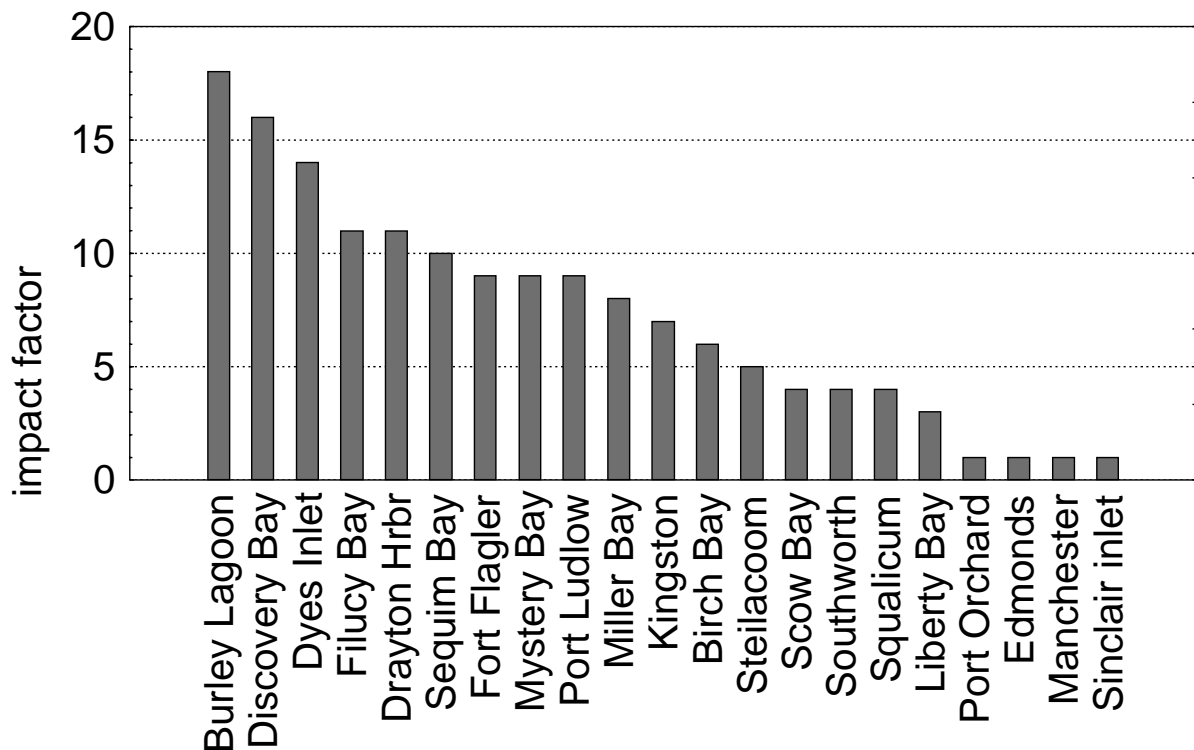
“**Low**” percentages times 1;

“**Moderate**” percentage times 2;

“**High**” percentage times 3.

The weighted percentages were then added to produce a single value for each Sentinel site (Figure 2).

There appears to be little positive correlation between PSP impact and human activity. Eight of the 10 sites with the highest Impact Factors are located in areas of minimal to moderate rural activity. On the other hand, 3 of 6 sites with the least impact are located in urbanized areas (Squalicum Harbor near Bellingham, Liberty Bay, and Sinclair Inlet).



**Figure 2.** Ranking of PSP-impacted Sentinel sites in Puget Sound during Year 2000

### Conclusions

- PSP episodes are currently unpredictable in time or space due to interaction of many poorly understood environmental factors.
- Protection of shellfish consumers from poisoning by biotoxins will require continued routine comprehensive monitoring throughout Puget Sound.

### Acknowledgements

The author recognizes citizen-monitors, shellfish growers, and cooperative staff from state, local and tribal agencies whose sampling efforts have helped protect the health of the people of Washington and many others far beyond our borders.

## **References**

- American Public Health Association, 1984, Laboratory procedures for the examination of seawater and shellfish. APHA, Washington DC.
- Boczar, B.A., M.K. Beitler, J. Liston, J.J. Sullivan, and R.A. Cattolico, 1988, Paralytic shellfish toxins in *Protogonyaulax tamarensis* and *Protogonyaulax catenella* in axenic culture. Plant Physiology **88**:1285-1290.
- Nishitani, I., 1990. Suggestions for the Washington PSP monitoring program and PSP research. Prepared for Health Office of Shellfish Programs, Olympia WA. p12.
- Nishitani, L., K.K. Chew, and T. King, 1994. Gathering safe shellfish in Washington: avoiding paralytic shellfish poisoning. WSG-AS 94-01, Washington Sea Grant Program, Seattle WA. p8.